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Materiel Test Procedure 3-2-706
Aberdeen Proving Ground

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

NIGHT VISION DEVICES

1. OBJECTIVE

The objective of the procedures outlined in this MTP is to provide a method of evaluating the effectiveness of night vision devices in enabling personnel to "see" under the low ambient light levels of nightime environment.

2. BACKGROUND

A night vision device is an electro-optical viewing instrument that images and amplifies the available illumination from a scene by means of a low-light-level, image-intensifier tube energized by an electronic power supply. It can be a small, handheld item, or it can be a larger item mounted on a tripod, weapon, or vehicle (MTP 2-2-616). Some of the devices have a reticle for use in estimating range or aiming weapons.

Night vision devices may be either passive or active, depending upon their source of illumination. Passive devices use only the light available from the moon or stars (10^{-2} to 10^{-5} foot-candles) as a light source. This light is amplified by means of the image intensifier tube to produce a visible picture of the scene being observed. Active devices depend on an artificial source of light which may or may not be visible to the unaided eye. When the light rays of the source are reflected back from the scene and focused on the image intensifier tube, the light is amplified to produce the visible picture.

Active light sources can sometimes be used with certain passive devices, under extremely dark conditions, to augment the small amount of ambient light that is available.

Engineers and other personnel engaged in testing and evaluating optical devices have developed over a long period time, certain procedures for testing. Properly used, these procedures can aid in determining the acceptability of night vision devices for an intended use. The devices must adhere to government and manufacturer's specifications to be accepted.

3. REQUIRED EQUIPMENT

a. Calibrated Light Level Meter(photometer)
b. Night Vision Devices
c. Standard Resolution Charts (NB of S)
d. Appropriate Targets
e. Environmental Test Chambers
f. Vibration Machine
g. Optical Traversing Mount

4. REFERENCES

A. AR 705-15, Operation of Materiel Under Extreme Conditions of Environment, 4 October 1962, with Change 1, 14 October 1963 or as superseded.
B. TM 9-2601, Elementary Optics and Applications to Fire Control Instruments, April 1945.
C. MIL-STD-810B, 15 June 1967, Environmental Test Methods.
D. MIL-O-13830, Optical Components for Fire Control Instruments: General Specification Governing the Manufacture, Assembly and Inspection of, 11 September 1963.
E. Morton, G.A., Image Intensifiers and the Scotoscope, Applied Optics, June 1964.
F. MTP 3-2-503, Safety Evaluation - Electronic and Fire Control Equipment.
G. MTP 3-2-708, Electronic Power Supplies
H. MTP 2-2-616, Night Performance
I. MTP 4-2-804, Laboratory Vibration Tests
J. MTP 5-2-582, Temperature - Altitude Test
K. MTP 5-2-583, Low Temperature Tests
L. MTP 5-2-589, Dust Tests
M. MTP 5-2-590, Salt Fog Test
N. MTP 5-2-591, Rain Tests
O. MTP 5-2-592, Humidity Tests
P. MTP 5-2-593, High Temperature with Solar Radiation

5. SCOPE

5.1 SUMMARY

This ~~MTP~~ describes in general terms the tests required to evaluate night vision devices, including safety tests and procedures for measuring the optical and operational characteristics of the item. Tests are also included for simulated climatic and transportation-vibration environments.

The specific tests listed below shall be conducted under procedures contained herein:

a. Safety Tests - This subtest determines the inherent safety associated with use of the night vision device.
b. Optical Measurements - This subtest determines the magnification, angular field of view, resolution, luminous gain, reticle accuracy and the minimum and maximum range of focus adjustment of the night vision device.
c. Operational Measurements - This subtest determines the operational range of the night vision device against various types of targets and its electrical characteristics.
d. Environmental tests - This subtest determines the deleterious effects of immersion in fresh and salt water, low temperature, high temperature and solar radiation, humidity, altitude, salt spray, rainfall, sand and dust, and vibration on the performance of the night vision device.

5.2 LIMITATIONS

The variety of night vision devices to which this MTP is applicable precludes detailed coverage of any particular item. The testing methods outlined are intentionally general to provide test coverage for various night vision devices and may be adapted, as necessary, to accommodate specific equipment.

6. PROCEDURE

6.1 PREPARATION FOR TEST

a. Select test equipment having an accuracy of at least ten times that of the function to be measured.

b. Carefully inspect the test item(s) to ensure that no damage has been incurred during transit and that the item(s) are free of manufacturing defects. Record any such damage or deficiencies noted.

c. Record the following information:

1) Nomenclature, serial number(s), and the manufacturer's name of the test item(s).
2) Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

d. Assure that all test personnel are familiar with the required technical and operational characteristics of the item under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC).

e. Review all instructional material issued with the test item by the manufacturer, contractor, or government as well as reports of previous similar tests conducted on the same type of test items, and familiarize all test personnel with the contents of such documents. These documents shall be kept readily available for reference.

f. Prepare record forms for systematic entry of data, chronology of test, and analysis in final evaluation.

g. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety SOP's are observed throughout the tests.

6.2 TEST CONDUCT

6.2.1 Safety Test

a. Perform a safety evaluation of the test item in accordance with the procedures given in MTP 3-2-503. Record results.

b. Utilizing a calibrated light level meter, perform an output light level measurement test in accordance with published instructions. During this test, any flash-protection portion of the test item shall be evaluated.

c. Verify the Safety Statement of the developer by determining whether the intensity of the output light from the test item is safe for the eye of the observer when the item is exposed to intense light sources.

d. Record the following:

1) Any unsafe or hazardous conditions associated with the operation of the test item.
2) The output light level when the test item is exposed to intense light sources.

6.2.2 Optical Measurements

6.2.2.1 Magnification

a. Mark a number of connected squares of equal size in a line on a distant white wall.

b. Establish a level of illumination low enough to prevent damage to the screen or phospher of the night vision device, but not so low as to prevent the squares being viewed with the eye and the night vision device simultaneously.

c. Observe the squares with both eyes, the right eye using the night vision device.

NOTE: The right eye will receive a magnified view of one or two squares; the left eye will receive a natural view of a number of squares. The overall visual impression will consist of a large square superimposed by a number of smaller squares.

d. Record the number of smaller squares per one large square and the light level used during the measurements.

e. Repeat the test as necessary to obtain the required data or to resolve incongruities.

6.2.2.2 Field of View

a. Install a target containing a vertical line and a horizontal line on a distant white wall.

b. Place the night vision device in an optical traversing mount equipped with levels and calibrated azimuth and elevation scales.

c. Level the night vision device and traverse the mount until the vertical target line is viewed at the left edge of the field of view.

NOTE: Ensure that the eye is centered along the optical axis, and not moved to the left or right edges of the exit pupil to obtain field of view.

d. Read and record the azimuth scale on the fixture.

e. Traverse the device until the vertical target line is at the right edge of the field of view.

NOTE: Extreme care must be taken when traversing the device to avoid errors due to backlash in gearing.

f. Read and record the azimuth scale on the fixture.

g. Repeat Steps (c), (d), (e), and (f) above a minimum of two times.

h. Elevate the mount until the horizontal target line is viewed at the bottom edge of the field of view.

i. Read and record the elevation scale on the fixtures.

j. Depress the mount until the horizontal target line is viewed at the top edge of the field of view. (Care must be taken that the eye is centered along the optical axis and backlash avoided, as in measuring the azimuth field of view).

k. Read and record the elevation scale on the fixture.

l. Repeat Steps (h), (i), (j), and (k) above a minimum of two times.

6.2.2.3 Resolution

a. Install standard resolution charts (obtained from the National Bureau of Standards) in a darkened room, at the chart specified distances at which resolution is to be measured.

b. Illuminate the resolution chart with a background light level of 10^{-5} foot-candles.

c. Utilizing the night vision device, observe the set of chart resolution lines most closely spaced that are just discernible as distinctly separated lines.

d. Record the numerical resolution of the night vision device as indicated by the chart for the set of lines observed in Step (c) above.

e. Repeat Steps (b), (c), and (d) above, illuminating the resolution charts with background light levels of 10^{-4}, 10^{-3}, 10^{-2}, and 10^{-1} foot-candles.

6.2.2.4 Luminous Gain

a. Install the night vision device in a darkened room and establish a light level of 10^{-5} foot-candles.

b. Utilizing a photometer or other calibrated light measuring instrument, measure and record the light being emitted from the image intensifier tube of the night vision device.

6.2.2.5 Reticle Accuracy

6.2.2.5.1 Fixed Reticle

a. Install a target containing a vertical line and a horizontal line on a distant white wall.

b. Place the night vision device in an optical traversing mount equipped with levels and calibrated azimuth and elevation scales.

c. Level the night vision device and traverse the mount in azimuth until the vertical target line is set coincident with one azimuth reticle division line.

d. Read and record the azimuth scale on the fixture.

e. Traverse the device and fixture in azimuth until the vertical target line is coincident with the adjacent reticle division line.

f. Read and record the azimuth scale on the fixture.

g. Repeat Steps (e) and (f) above, for each division of the reticle.

h. Traverse the mount in elevation until the horizontal target line is set coincident with one elevation reticle division line.

i. Read and record the elevation scale on the fixture.

j. Traverse the device and fixture in elevation until the horizontal target line is coincident with the adjacent reticle division line.

k. Read and record the elevation scale on the fixture.

l. Repeat Steps (j) and (k) above, for each division of the reticle.

6.2.2.5.2 Adjustable Reticle

a. With the night vision device placed in the same optical mounting fixture that was used above, set the reticle center coincident with the target line (azimuth or elevation).

b. Read and record the scale on the fixture (azimuth or elevation).

c. Turn the reticle knob one "click" (one increment of adjustment), and traverse the device and fixture until the reticle center is again coincident with the target line.

d. Read and record the scale on the fixture.

e. Repeat the test for each click of the reticle knob in azimuth and elevation.

6.2.2.6 Focus

a. Set the focus adjustment knob of the night vision device for minimum range, and illuminate a darkened room at a level of 10^{-2} foot-candles.

b. Slowly move a standard resolution chart (See paragraph 6.2.2.3) toward the night vision device until it reaches the minimum distance at which the chart lines (as viewed by the night vision device) are clearly focused.

c. Measure the distance established in Step (b) above, and record as the minimum range of focus of the night vision device.

d. Set the focus adjustment knob of the device for maximum range, and slowly move the chart away from the device until the maximum range for focusing clearly is reached.

e. Measure the distance established in Step (d) above, and record as the maximum range of focus of the night vision device.

NOTE: If a star in the sky can be clearly focused, maximum range of focus is considered to be infinity.

6.2.3 Operational Measurements

6.2.3.1 Operational Range

a. Establish various targets, of the type normally encountered with the night vision device being used, using the following criterion:

1) Both stationary and moving type targets shall be employed.
2) The targets shall be placed at ranges greater than the maximum range of the night vision device.
3) The types of targets and the range of each shall initially be unknown to the observer.

b. Decrease the distance between the night vision device and the targets until detection, recognition, and identification of the targets is accomplished.

c. Record the range to the target for each of the three conditions.

NOTE: The three conditions are defined as:

1) Detection - Indication of the presence of a target of potential military interest by sensing a contrast between the target and the background.
2) Recognition - Discrimination between targets as to class - e.g., tank, truck, man - by defining the target silhouette.
3) Identification - Discrimination between targets within a class - e.g., M60 tank, T54 tank - by observing individual characteristics.

d. Record the following information:

1) Direction and speed of the moving targets
2) Phase of the moon
3) Ambient light level (measured with a photometer every 30 minutes and also whenever starlight or moonlight conditions change due to cloud cover or other conditions affecting a light level reading).
4) Type of background
5) Contrast of each target with its background
6) Weather conditions to include:

a) Haze
b) Fog
c) Rain
d) Snow
e) Temperature
f) Relative humidity
g) Wind velocity
h) Visibility
i) Percentage of cloud cover

e. Repeat the entire test as necessary to obtain the required data.

6.2.3.2 Electrical Characteristics

a. Subject the electronic power supply of the night vision device to the procedures contained in MTP 3-2-708.

b. Note and record the location and magnitude of any high voltage of the night vision device, and any improper operation of all electrical circuits.

c. Operate the night vision device over the period of time specified in applicable publications such as QMR, SDR, or TC, and note and record any significant change in the electrical characteristics.

6.2.4 Environmental Test

6.2.4.1 Immersion Tests

a. Subject the night vision device to the operational tests described in paragraph 6.2.3, and record results.

NOTE: The above results shall serve as the criteria for determining degradation of performance upon completion of the immersion test.

b. Submerge the test item in a tank containing 3 feet of fresh water that has a temperature of 95° to 105° F for a period of 30 minutes.

c. Remove the night vision device from the tank, carefully examine the item, and record the ability of hermetic seals and gaskets to prevent leakage.

d. Submerge the device in a tank containing 3 feet of salt water that has a temperature of 68° to 95° F for a period of 30 minutes.

e. Repeat Step (c) above.

f. Subject the item under test to the operational tests given in paragraph 6.2.3, and record results.

6.2.4.2 Low Temperature Tests

a. Subject the night vision device to low temperature tests in accordance with the procedures given in MTP 5-2-583.

6.2.4.3 High Temperature and Solar Radiation Tests

a. Subject the night vision device to the high temperature with solar radiation tests given in MTP 5-2-593.

6.2.4.4 Humidity Tests

a. Subject the night vision device to humidity testing in accordance with the procedures contained in MTP 5-2-592.

6.2.4.5 Altitude Tests

a. Subject the night vision device to the appropriate temperature-altitude tests contained in MTP 5-2-582.

6.2.4.6 Salt Spray Tests

a. Subject the night vision device to salt-fog tests in accordance with the procedures given in MTP 5-2-590.

6.2.4.7 Rain Tests

a. Subject the night vision device to 9.5 inches of simulated rain-fall (blown at the test item from four directions) in accordance with the procedures given in MTP 5-2-591.

6.2.4.8 Sand and Dust Tests

a. Subject the night vision device to sand and dust tests in accordance with the procedures contained in MTP 5-2-589.

6.2.4.9 Transportation Vibration Tests

a. Subject the night vision device to the operational tests given in paragraph 6.2.3, and record results.

NOTE: The above results shall serve as a reference for determining compliance with satisfactory performance upon completion of vibration testing.

b. Place the test item in its carrying case and fasten it to a vibration machine.

c. Subject the device to vibration simulating a composite transportation environment of 3 hours in an aircraft and 1500 miles in two-wheeled trailers, in accordance with the procedures contained in MTP 4-2-804.

d. Remove the night vision device from the vibration machine, carefully examine it, subject the device to the operational tests given in paragraph 6.2.3, and record results.

6.3 TEST DATA

6.3.1 Preparation for Test

Data to be recorded prior to testing will include but not be limited to:

a. Nomenclature, serial number(s), and the manufacturer's name of the test items.

b. Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

c. Damages to the test item(s) incurred during transit and/or manufacturing defects.

6.3.2 Test Conduct

Data to be recorded in addition to specific instructions listed for each subtest shall include:

a. Photographs or motion pictures (black and white or color), radiographs, sketches, maps, charts, graphs, or other pictorial or graphic presentation which will support test results or conclusions.

b. An engineering logbook containing, in chronological order, pertinent remarks and observations which would aid in a subsequent analysis of the test data. This information may consist of a description of equipment or components, and functions and deficiencies, as well as theoretical estimations, mathematical calculations, test conditions, intermittent or catastrophic failures, test parameters, etc., that were obtained during the test.

c. Instrumentation or measurement system mean error stated accuracy.

d. Test item sample size (number of measurement repetition).

6.3.2.1 Safety Test

Data to be recorded shall consist of:

a. Safety evaluation in accordance with MTP 3-2-503.

b. Any unsafe or hazardous conditions associated with the operation of the test item.

c. The output light level when the test item is exposed to intense light sources.

d. Investigation of any irritation or possible damage to eyes or vision of personnel operating the test item at night.

6.3.2.2 Optical Measurements

6.3.2.2.1 Magnification

a. Record the number of smaller squares per one large square.

b. Record the light level used during each measurement.

6.3.2.2.2 Field of View

a. Record the azimuth scale readings with the vertical target line at the left and right edges of the field of view.

b. Record the elevation scale readings with the horizontal target line at the top and bottom edges of the field of view.

6.3.2.2.3 Resolution

a. Record the numerical resolution of the night vision device as indicated by the chart for the set of lines that are just discernible as distinctly separated lines.

b. Record the light level used for each measurement.

6.3.2.2.4 Luminous Gain

a. Record the light level entering the night vision device.
b. Record the light level being emitted from the image tube.

6.3.2.2.5 Reticle Accuracy

a. Fixed reticle

1) Record the azimuth scale reading when the vertical target line is set coincident with each azimuth reticle division line.
2) Record the elevation scale reading when the horizontal target line is set coincident with each elevation reticle division line.

b. Adjustable reticle

1) Record the azimuth scale reading when the vertical target line is set coincident with each azimuth reticle division line.
2) Record the elevation scale reading when the horizontal target line is set coincident with each elevation reticle division line.

6.3.2.2.6 Focus

a. Record the minimum distance at which the chart lines can be clearly focused.
b. Record the maximum distance at which the chart lines can be clearly focused.

6.3.2.3 Operational Measurements

6.3.2.3.1 Operational Range

Record the following:

a. Detection, recognition, and identification range for each target
b. Direction and speed of the moving targets
c. Phase of the moon
d. Ambient light level
e. Type of background
f. Contrast of target with its background
g. Weather conditions to include:

1) Haze
2) Fog
3) Rain
4) Snow
5) Temperature
6) Relative humidity
7) Wind velocity
8) Visibility
9) Percentage of cloud cover

6.3.2.3.2 Electrical Characteristics

Record the following:

a. All data required in accordance with MTP 3-2-708.
b. Location and magnitude of any high voltage
c. Any improper operation of all electrical circuits

6.3.2.4 Environmental Tests

6.3.2.4.1 Immersion Test

Record the following:

a. Results of pre-test operational tests
b. Observations and pertinent remarks concerning the ability of hermetic seals and gaskets to prevent leakage
c. Results of post-test operational tests

6.3.2.4.2 Low Temperature Tests

Record all data required in accordance with MTP 5-2-583.

6.3.2.4.3 High Temperature and Solar Radiation Tests

Record all data required in accordance with MTP 5-2-593

6.3.2.4.4 Humidity Tests

Record all data required in accordance with MTP 5-2-592.

6.3.2.4.5 Altitude Tests

Record all data required in accordance with MTP 5-2-582.

6.3.2.4.6 Salt Spry Tests

Record all data required in accordance with MTP 5-2-590.

6.3.2.4.7 Rain Tests

Record all data required in accordance with MTP 5-2-591.

6.3.2.4.8 Sand and Dust Tests

Record all data required in accordance with MTP 5-2-589.

6.3.2.4.9 Transportation Vibration Tests

Record the following:

a. Results of pre-test operational tests
b. All data required in accordance with MTP 4-2-804.
c. Results of post-test operational tests.

6.4 DATA REDUCTION AND PRESENTATION

Processing of raw test data shall, in general, consist of organizing, marking for identification and correlation and grouping the test data according to test title.

Specific instructions for the reduction and presentation of individual test data are outlined in succeeding paragraphs.

6.4.1 Safety Tests

Data from this subtest shall be reduced and presented as prescribed in MTP 3-2-503.

6.4.2 Optical Measurements

6.4.2.1 Magnification - The magnification of the night vision device is the visually observed ratio of the number of smaller squares per one large square.

6.4.2.2 Field of View - The difference between the azimuth scale reading with the vertical target line at the left edge of the field of view and the scale reading with the vertical target line at the right edge of the field of view is the angular measurement of the horizontal field of view of the night vision device. The angular measurement of the vertical field of view is the difference between the elevation scale readings with the horizontal target line at the top and bottom edges of the field of view.

6.4.2.3 Resolution - The resolution of the night vision device is read directly from the standard resolution charts for each background light level.

6.4.2.4 Luminous Gain - The ratio of the illumination level of light being emitted from the image intensifier tube to the illumination level of the light entering the image intensifier tube is the luminous gain of the tube.

6.4.2.5 Reticle

a. Fixed Reticle - The difference between the azimuth or elevation scale readings from one reticle division line to the adjacent reticle division line is the subtended angle per reticle division of the night vision device.

b. Adjustable Reticle - The difference between the azimuth or elevation scale readings from one reticle division line to the adjacent reticle division line is the angle of adjustment per one reticle knob click. The total of the angles read is the total angle of adjustment of the night vision device reticle.

6.4.2.6 Focus - The minimum and maximum ranges of focus adjustment that can be obtained with the night vision device are determined by measuring the distance from the standard resolution chart to the night vision device.

6.4.3 Operational Measurements

6.4.3.1 Operational Range - The distances between the night vision device and the various types of targets at detection, recognition, and identification of the targets shall be compared with specifications for the night vision device.

6.4.3.2 Electrical Characteristics - The data obtained from this subtest shall be reduced and presented as prescribed in MTP 3-2-708. Any significant change in the electrical characteristics of the power supply caused by continuous operation over the specified time shall be compared to specifications for the device.

6.4.4 Environmental Tests

6.4.4.1 Immersion Test - The ability of mermetic seals and gaskets to prevent leakage of water into the night vision device shall be compared with applicable specifications. Any impairment of operational ability of the item caused by leakage shall provide reason to consider the device as having failed the test.

6.4.4.2 Low Temperature Tests - The data obtained from this subtest shall be reduced and presented in accordance with MTP 5-2-583.

6.4.4.3 High Temperature and Solar Radiation Tests - The data obtained from this subtests shall be reduced and presented in accordance with MTP 5-2-593.

6.4.4.4 Humidity Tests - Data derived from this subtest shall be reduced and presented as prescribed in MTP 5-2-592.

6.4.4.5 Altitude Tests - All data obtained from this subtest shall be reduced and presented in accordance with MTP 5-2-582.

6.4.4.6 Salt Spray Tests - The data derived from this subtest shall be reduced and presented in accordance with MTP 5-2-590.

6.4.4.7 Rain Test - The data derived from this subtest shall be reduced and presented and prescribed in MTP 5-2-591.

6.4.4.8 Sand and Dust Tests - All data obtained from this subtest shall be reduced and presented in accordance with MTP 5-2-589.

6.4.4.9 Transportation Vibration Tests - The data derived from this subtest shall be reduced and presented as prescribed in MTP 4-2-804.

A written report shall accompany all test data and shall consist of conclusions and recommendations drawn from test results. The test engineer's opinion, concerning the success or failure of any of the functions evaluated, shall be included. In addition, equipment specifications that will serve as the model for a comparison of the actual test results should be included.

Equipment evaluation usually will be limited to comparing the actual test results to the equipment specifications and the requirements as imposed by the intended usage. The results may also be compared to data gathered from previous tests of similar equipment.